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ABSTRACT

Sibling data drawn from the Kalamazoo Brothers sample are used in this report to assess the adequacy of conventional sociological variables for measuring family background, to estimate the overall effects of family background on test scores, education, occupational status, and earning, and to control family background when estimating the effects of test scores and education. Traditional socioeconomic variables are found to be imperfect measures of background. The correlations between brothers' test scores, educational attainment, occupational status, and earnings are substantially higher than would be predicted on the basis of measured socioeconomic background alone. Nevertheless, the differences between brothers on measures of economic success are large relative to differences among men in general. Differences in family background explain less than one quarter of the variance in earnings. Biases in the effects of education on occupational status and earnings due to background are not fully eliminated by controlling only measured background variables. Controlling both sibling test score differences and common family background suggests a 30% bias in the education-occupation coefficient and a 54% bias in the education income earnings coefficient. Controlling common family background does not, however, substantially reduce the effect of test scores on income earnings. (Author/AM)

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ON THE USE OF SIBLING DATA TO ESTIMATE THE EFFECTS OF FAMILY BACKGROUND, COGNITIVE SKILLS, AND SCHOOLING: RESULTS FROM THE KALAMAZOO BROTHERS STUDY

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On the Use of Sibling Data to Estimate the Effects of Family Background, Cognitive Skills, and Schooling: Results from the Kalamazoo Brothers Study

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ABSTRACT

Sibling data drawn from the Kalamazoo Brothers sample are used to assess the adequacy of conventional sociological variables for measuring family background, to estimate the overall effects of family background on test scores, education, occupational status, and earnings, and to control family background when estimating the effects of test scores and education.

Traditional socioeconomic variables are imperfect measures of background. The correlations between brothers' test scores, educational attainments, occupational statuses, and earnings are substantially higher than would be predicted on the basis of measured socioeconomic background alone. Nevertheless, the differences between brothers on measures of economic success are large relative to differences among men in general. Differences in family background explain less than one quarter of the variance in earnings.

Biases in the effects of education on occupational status and earnings due to background are not fully eliminated by controlling only measured background variables. Controlling both sibling test score differences and common family background suggests a 30 percent bias in the education-occupation coefficient and a 54 percent bias in the education-ln earnings coefficient. Controlling common family background does not, however, substantially reduce the effect of test scores on ln earnings.

Introduction

During the last ten years, sociologists have devoted considerable effort to measuring and modeling the effects of family background on the economic attainments of men [Blau and Duncan, 1967; Duncan, Featherman, and Duncan, 1972; Jencks et. al., 1972; Sewell and Hauser, 1975.] In addition to assessing the quantitative importance of background, they have attempted to trace the extent to which background affects economic standing by affecting cognitive skills and educational attainment. In the process of decomposing the effects of background into direct and indirect components, sociologists have estimated standardized regression coefficients for ability and schooling in models of occupational status and earnings. This work has brought them close afield to interests usually pursued by economists.

Economists of the human capital persuasion have had to contend with the possibility that what appear to be the effects of schooling are, in fact, the effects of the determinants of schooling. Concern with this question has usually centered on the impact of ignoring family background and tested mental ability when estimating the effects of schooling on earnings [Griliches and Mason, 1972; Taubman and Wales, 1974; Welch, 1974.]

Both sociologists and economists have usually equated family background with measures of socioeconomic position. Variables that are commonly employed include parental education, family size, and father's occupational status. Critics have been quick to point out that potentially important

background measures, such as parental income, are usually omitted [Bowles, 1972].[1] The problem is further complicated by the fact that families may systematically confer advantages and disadvantages in ways that are unrelated to socioeconomic position. "Family climates" and other elusive factors may well vary between families that are equal on all conceivable measures of socioeconomic status and demographic characteristics. If that is true, the explained variance in ordinary models of status attainment underestimates the explanatory power of family background. Moreover, if the unmeasured aspects of family background that affect education are correlated with those that affect occupational status or income, controlling measured socioeconomic variables will not suffice to eliminate biases in the education coefficients due to background.

An alternative definition of family background includes all those factors, both measured and unmeasured, that produce resemblance on outcomes among siblings. If the effects of family background do not vary systematically by birth order or other within-family factors, and if the characteristics

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[1] What direct evidence there is suggests that the inclusion of parental income reduces the coefficients of other background measures, but that it does not significantly enhance the explanatory power of measured background. I reanalyzed Sewell and Hauser's sample of 1957 Wisconsin high school Seniors, and found that the addition of average parental income from 1957 to 1960 to equations already including father's education, mother's education, and father's occupation did not significantly reduce the residual standard errors for educational attainment, 1964 occupational status, and 1967 earnings.

of one sibling do not directly affect the characteristics of another, the sibling correlation for an outcome represents the total proportion of variance which background explains.[2] If the entire effect of background defined in this way was produced by measured socioeconomic variables, the R^2's from ordinary individual level regressions would be the same as the sibling correlations. Blau and Duncan [1967] report, however, that this is not the case for educational attainment. My data suggest that it is also not the case for occupational status or earnings. They suggest that

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[2] If the assumptions do not hold, the sibling correlation still reflects the extent to which between-family variance exceeds within-family variance, but the interpretation of the correlation becomes ambiguous. If the effects of background vary by birth order, the proportion of variance due to family and to such an interaction could be higher than the sibling correlation. If brothers' characteristics directly affect one another, the sibling correlation exceeds the variance attributable to shared background characteristics. Fortunately, the assumptions that background effects are symmetric by birth order, and that interbrother effects are for the most part unlikely appear tenable for the Kalamazoo data. See Michael Olneck, "The Determinants of Educational Attainment and Adult Status Among Brothers: The Kalamazoo Study," doctoral dissertation, Chapter 4. Harvard Graduate School of Education, 1976.

Two other caveats are in order. If background factors have different effects for men with no brothers, estimates of explained variance based on sibling data may be misleading for the general population. This possibility cannot be tested for unmeasured background factors. Nor am I familiar with analyses of national data which relate outcomes to measured variables separately for men with brothers and men with no brothers. Such analyses could be conducted with the 1962 and 1973 OCG data. See Peter Blau and Otis D. Duncan, The American Occupational Structure (New York: Wiley, 1967); David L. Featherman and Robert Hauser, "Design for a Replicate Study of Social Mobility in the United States," in Social Indicator Models, eds. Kenneth C. Land and Seymour Spilerman (New York: Russell Sage, 1975).

My definition of "background" includes the effects of genes, but only to the extent that brothers' genetic makeups are correlated. If genes are viewed as an "inheritance", I have underestimated the effects of background even when using sibling data. However, unshared, unmeasured environmental factors whose effects I cannot analyse may also be related to family background in a narrow sense, and in a wider sense are almost definitionally related to background. No methodology can analytically distinguish unmeasured individual "background" factors from "later" influences.

ordinary socioeconomic variables are very imperfect measures of family background.[3] Models of the attainment process which ignore this not only underestimate the overall effects of background, but may also overestimate the extent to which ability and schooling mediate the impact of background on economic attainment.

If the omitted aspects of family background that affect schooling and economic outcomes are uncorrelated, researchers who rely on socioeconomic measures to control background are on safe ground. But if such factors are correlated, estimates of the effects of schooling will be biased to some extent even if socioeconomic background is controlled. By running regressions on sibling differences (or on deviations from pair means), one can control all those family-related factors which brothers share. The effects of schooling or other variables such as tested ability measured within families cannot be biased by family background.[4] They can, unhappily, still be biased by unmeasured characteristics which vary between brother.

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[3] This would be true even if socioeconomic variables were measured without error. While R^2's from equations using corrected variables are higher than those from equations using observed measures, corrected sibling correlations are also higher. See Olneck, "Determinants of Educational Attainment," Table 4.7.

[4] For an early anticipation of this strategy, see Donald E. Gorseline, The Effect of Schooling upon Income, Graduate Council of Indiana University, 1932. For reanalyses of Gorseline's data, see Gary Chamberlain and Zvi Griliches, "Returns to Schooling of Brothers and Ability as an Unobserved Variance Component," Harvard Institute of Economic Research Discussion Paper, 340 (Cambridge, Mass.: Institute of Economic Research, 1974). For further within-pair regression results see Jeremy Behrman, Paul Taubman, and Terence Wales, "Controlling for and Measuring the Effects of Genetics and Family Environment in Equations for Schooling and Labor Market Success," Paper prepared for presentation at the Mathematical Social Sciences Board Conference on Kinametrics, May 1976, at

Work in status attainment research and in econometric analyses of the effects of education is hampered not only by inadequate measures of family background, but also by the scarcity of data that include ability measures. From the point of view of sociology, which takes a substantive interest in the effects of cognitive skills, the problem is one of scarcity pure and simple. From the point of view of econometrics, the problem is also conceptual. Traditional cognitive tests may not capture what economists mean by "ability"--i.e., the ability to earn a higher wage irrespective of schooling. Viewed in this light, test scores are possibly error-ridden proxies for "true" ability. However, until economists can specify what such ability is, we will have to be content with the measures that are available. The availability in the Kalamazoo Brothers sample of early test scores for men over the age of 35, adds somewhat to the small stock of existing data which allows useful analyze of the interrelationships among background, ability, schooling, and economic success.[5]

Williamstown, Massachusetts.

The strategy involves two hazards which I discuss in more detail below. The first is that it assumes variables measure the same things within and between families. The second is that it exacerbates biases due to measurement errors.

See John Bishop, "Reporting Errors and the True Return to Schooling," unpublished paper (Madison: University of Wisconsin, 1976).

[5] The Wisconsin 1957 high school Seniors studied by Sewell and Hauser are only now in their mid-thirties, and the sample excludes high school dropouts. Published analyses of this sample cover earnings only ten years after high school graduation. See William H. Sewell and Robert M. Hauser, Education.

This paper reports the results of my efforts to use the Kalamazoo Brothers data to estimate the effects of family background on cognitive

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Occupation, and Earnings (New York: Academic Press, 1975). The Project Talent respondents were only around 28 years old when last surveyed. See James Crouse, "The Project Talent 11-14 Year Longitudinal Surveys," in Who Gets Ahead?, ed. Christopher Jencks, draft, Appendix H (New York: Basic Books, forthcoming). The effects of cognitive skills on earnings appear to be lower in the early career than later on. (See Hause's report of Roger's data; also see Jencks, and Fägerlind. Unpublished data from the Wisconsin sample also show their effect.) John C. Hause, "Earnings Profile: Ability and Schooling," Journal of Political Economy 80 (May/June 1972); Christopher Jencks, (ed.), Who Gets Ahead? (New York: Basic Books, forthcoming); Ingemar Fägerlind, Formal Education and Adult Earnings (Stockholm: Almquist and Wiksell, 1975). This means that analysts who have relied on younger samples may have prematurely concluded that the ability bias in the income-schooling relationship is small. For example, Griliches and Mason concludes that the bias in postmilitary schooling in the NORC Veterans sample is only 10 percent. I found the bias in the coefficient for total schooling for respondents 30-34 in that sample to be 42 percent. See Zvi Griliches and William M. Mason, "Education, Income and Ability," Journal of Political Economy 80 (May/June 1972); Michael Olneck, "The Effects of Education on Occupational Status and Earnings," Institute for Research on Poverty Discussion Paper, 358-76 (Madison: Institute for Research on Poverty, 1976).

Unfortunately, samples of older men which include test scores are rare, and, invariably, flawed. The test in the Michigan Panel Study of Income Dynamics is unreliable, and was taken at the time the survey was administered. See Peter Mueser. "The 1967-74 Panel Study of Income Dynamics' Survey," in Who Gets Ahead?, ed. Christopher Jencks, draft, Appendix C (New York: Basic Books, forthcoming). Respondents in the NBER-TH sample were all in the military and scored at or above the median. (Paul Taubman and Terence Wales, Higher Education and Earnings: College as an Investment and a Screening Device (New York: McGraw-Hill, 1974.)

Because of its local nature, the Kalamazoo data does not remedy the need for large, representative samples with ability measures. That it adds significantly to available data reflects the meager base on which analyses in this area are conducted.

skills, educational attainment, occupational status, and earnings, and to control family background when estimating the effects of cognitive skills on educational attainment, and cognitive skills and education on occupational status and earnings. In Section 2, I describe the sample and the variables. Section 3 compares the sibling correlations predicted by the effects of measured background to those actually observed, and compares the magnitude of sibling differences to the magnitude of differenced between randomly chosen individuals. I also develop alternative models representing the effects of background. And in Section 4, I compare the results of within-pair regressions to individual level regressions. Section 5 summarizes my results and suggests their implications for further research.

Section 2. Sample and Variable Descriptions

The Kalamazoo, Michigan public school system has preserved the results of its standardized testing program since the program's inception in 1928. During the summer of 1973, I selected a sample of males from the records of sixth grade scores for the years 1928 thru 1950.* I used school census and enrollment records to determine siblingship. This procedure resulted in a potential sample of 2782 individuals from 1224 sets of brothers.

I was able to trace 1612 of the original 2782 individuals in the sample. Of these, 1243 completed a follow-up telephone interview during

* I am grateful to Dr. William Coates and Dr. David Bartz of the Kalamazoo Public School System for permission to use the Kalamazoo school records. I am grateful to Dr. Stanley Robin, director of the Center for Sociological Research at Western Michigan University for extending the courtesies of the Center to me during the interview phase of the study.

September 1973 thru May 1974; 152 were dead, 52 were never directly contacted and 165 refused to be interviewed. When an interview was conducted with the first brother to be contacted in any set, the respondent was asked to report the schooling, occupation, and earnings of his other brothers who were also in the sample. I concluded that the reports of brothers' occupations and earnings are too unreliable to be substituted for self-reports [Olneck, 1976a, Chapter 4], so only men who completed an interview and who could be paired with at least one brother who also completed an interview are included in the present analyses. Satisfying that criterion were 916 respondents, however, item nonresponse on background variables, initial occupation and earnings by one or both brothers in a pair led to further attrition. The analyses reported here are for 692 individual respondents, or 346 weighted pairs.[6] Differences between the means, standard deviations, and correlations for the 1243 men interviewed and the 692 men comprising the present sample are negligible [Olneck, forthcoming, Tables 2 and 11]. The average test score for men in this sample is only 3.66 points higher than for men who were not interviewed (i.e., 100.89 v. 97.23). However, comparisons with national and regional data do suggest upward biases on some crucial variables.

Table 1 presents the means and standard deviations for the variables employed in the present analyses. They are compared to means and standard

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[6] One quarter of the respondents are from families in which more than two brothers were interviewed. Consequently, there are actually more than 346 unique pairs. I weighted the sample so that no family would count for more than one pair.

Table 1

Means and Standard Deviations of Variables in the Kalamazoo Brothers Sample (N=692) and the 1973 Occupational Changes in a Generation Replication Sample, Men 35 to 59 (N=9398)

Variables		Means		Standard Deviations	
		Kalamazoo	OCG II	Kalamazoo	OCG II
1.	Age	46.13	46.43	6.02	6.94
2.	Test score	100.89	NA	15.32	NA
3.	Father's education[a]	9.51	7.90	3.33	3.97
4.	Father's occupation[a]	38.33	28.29	22.52	21.83
5.	Siblings[a]	3.72	3.83	2.53	2.73
6.	Education	13.20	11.84	2.73	3.29
7.	Initial occupation	39.51	33.66	23.80	25.18
8.	Current occupation	49.91	43.18	23.17	25.65
9.	1973 Earnings (Kalamazoo) or Income (OCG II)	16745.66	12821.50 (12775.33)[b]	7633.78	9729.89 (7757.91)[b]
10.	Natural logarithm of 1973 earnings (Kalamazoo) Income (OCG II)	9.62	9.19 (9.25)[b]	0.45	1.07 (0.71)[b]

Table 1 Continued (2)

Variable Definitions in the Kalamazoo Sample

1. Age 1973 minus school record of year of birth.

2. Test score Score on Terman group test administered in the sixth grade or score on Otis group test adjusted for scaling differences and trends in parental education, father's occupational status, and family size. See Olneck [forthcoming], for adjustment procedure. Three-quarters of the respondents took the Terman test.

3. Father's education = Normative years completed (e.g., high school graduate is coded 12 even when it took 13 years to finish).

4. Father's occupation = Duncan Socioeconomic Index. See Duncan [1961].

5. Siblings = Number of siblings who grew up in respondent's family.

6. Education = Normative years completed.

7. Initial occupation = Duncan score for first full-time civilian job after completion of reported level of schooling.

8. Current occupation = Duncan score for current job.

9. 1973 Earnings = Expected annual earnings for 1973. Interviewers recorded only the interval in which respondents earnings fell. Reluctant respondents were encouraged to name an interval.

Interval	Coding	Percentage Among 1243 Interviewees
Under 1000	500	0.2%
1000-1999	1500	0.0
2000-2999	2500	0.1
3000-3999	3500	0.1
4000-4999	4500	0.6
5000-5999	5500	0.4
6000-6999	6500	1.4
7000-7999	7500	1.7
8000-9999	9000	8.8
10000-11999	11000	15.8
12000-13999	13000	17.8
14000-16999	15500	19.4
17000-19999	18500	10.2
20000-24999	22500	11.3
25000 and over	34000	12.1

Table 1 Continued (3)

NOTES:

a. Errors in these background measures appear random [Olneck, 1976, Chapter 4; Bielby, Hauser, and Featherman, 1976]. Self-reported outcomes correlate as well with background reported by brothers as with self-reported background. Therefore, when reports of father's education or occupation, or number of siblings were missing for a respondent, I substituted the report(s) provided by his brother where available. I deleted pairs in which both brothers failed to report a background measure.

b. OCG II income recoded to Kalamazoo coding scheme.

deviations for respondents also aged 35 to 59 from the 1973 replication of the nationally representative Occupational Changes in a Generation Survey.[7]

The Kalamazoo respondents are clearly advantaged on parental background and adult attainment compared to men of the same age in the nation as a whole. This is due, in part, to characteristics of Kalamazoo. The city has traditionally been an area of skilled employment. It has also had a public college (now university) for some years. The differences between the Kalamazoo and OCG II samples may also be due to my sampling and follow-up procedures. These did not include men who grew up in neighboring farm communities, and they were not likely to result in tracing men whose families left Kalamazoo in the years following the respondents enrollment in sixth grade unless relatives were still in Kalamazoo between 1973 and 1974.[8]

The OCG II sample which I looked at includes proportionately more men aged 55 to 59 than does my sample. This will tend to exaggerate the differences between the Kalamazoo and national data. Ninety percent of the

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[7] See Featherman and Hauser, "Design for a Replicate Study." I am grateful to Robert Hauser for making this information available to me.

[8] This speculation assumes that respondents' fathers who left Kalamazoo were disproportionately lower status. For support, at least for the early part of the century, see, Stephen Thernstrom, The Other Bostonians (Cambridge: Harvard University Press, 1973). For a contrary view which emphasizes the greater success of out-migrants and in-migrants among the 1972 OCG respondents, see Blau and Duncan, The American Occupational Structure, and Otis D. Duncan, David L. Featherman, and Beverly Duncan, Socioeconomic Background and Achievement (New York: Seminar Press, 1972).

men I interviewed were between 35 and 54 years of age.[9] Among U.S. married men aged 35 to 54 and living with their wives, average 1973 earnings were 15,000 dollars [U.S. Bureau of the Census, 1975, Table 34]. This is only 1250 dollars less than the average earnings in the Kalamazoo sample. Ninety-three percent of my respondents were married and living with their wives.

Table 2 compares correlations in the Kalamazoo sample to those in the OCG II sample. Correlations between measures of attainment are generally similar in the two samples. Differences between correlations involving Ln earnings and Ln income are due to differences in coding.[10] The larger correlation between age and father's occupation in the Kalamazoo sample may indicate that younger respondents in that sample come from atypically higher-status families. It may, however, indicate that shifts in the occupations held by fathers were more rapid in Kalamazoo than in the nation as a whole.

The most disturbing difference between the correlations from the Kalamazoo and OCG II samples is that occupation and recoded income are significantly more highly correlated with father's occupation and father's education in the OCG II sample. It is tempting to attribute this to the

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[9] Eighty-two percent of the OCG II men 35 to 59 were between 35 and 54.

[10] For discussion of this and other issues relating to differences in results across samples see Kent McClelland, "Why Different Surveys Yield Different Results: The Case of Education and Earnings," in Who Gets Ahead?, ed. Christopher Jencks, draft, Chapter 6. (New York: Basic Books, forthcoming).

Table 2

Correlations Among Variables in the Kalamazoo Brothers Sample (N=692) and the 1973 Occupational Changes in a Generation Replication Sample, Men 35 to 59 (N=9398) OCG shown below.

		1	2	3	4	5	6
1.	Age	1.000 1.000					
2.	Test Score	-.164 NA	1.000 NA				
3.	Father's Education	-.182 -.121	.261 NA	1.000 1.000			
4.	Father's Occupation	-.165 -.060*	.260 NA	.470 .501	1.000 1.000		
5.	Siblings	.066 .087	-.276 NA	-.250 -.308	-.224 -.295	1.000 1.000	
6.	Education	-.184 -.136	.576 NA	.400 .454	.383 .423	-.328 -.357	1.000 1.000
7.	Initial Occupation	-.140 -.112	.445 NA	.350 .356	.391 .426	-.256 -.302	.716 .659*
8.	Current Occupation	-.105 -.067	.453 NA	.215 .340*	.218 .392*	-.220 -.282	.591 .624
9.	Earnings (Kalamazoo) or Income[a] (OCG II)	-.071 -.021 (-.038)	.359 NA (NA)	.171 .228 (.260)*	.212 .261 (.298)*	-.155 -.191 (-.216)	.431 .388 (.452)
10.	Ln Earnings (Kalamazoo) or Ln Income[a] (OCG II)	-.083 -.048 (-.058)	.360 NA (NA)	.160 .167 (.233)	.197 .172 (.243)	.154 -.134 (-.188)	.407 .292* (.416)

Table 2 Continued (2)

		7	8	9	10
7.	Initial Occupation	1.000 1.000			
8.	Current Occupation	.563 .630*	1.000 1.000		
9.	Earnings or Income	.411 .378 (.429)	.482 .453 (.521)	1.000 1.000 (1.000)	
10.	Ln Earnings or Ln Income[a]	.386 .256* (.356)	.409 .336* (.466)	.938 .612* (.859)*	1.000 1.000 (1.000)

NOTES:

a. Correlations in parentheses pertain to OCG II income coded to Kalamazoo coding scheme.

* OCG significantly different from Kalamazoo at the .05 level.

local nature of the Kalamazoo sample.[11] However, the correlations between education and initial occupation on the one hand, and father's education and father's occupation on the other, are not significantly lower in the Kalamazoo sample than in the OCG II sample. This suggests that the Kalamazoo sample is comprised of respondents whose later (but not earlier) attainments are unusually independent of their parental backgrounds. This, in turn, suggests that rather than the process of attainment being atypically "meritocratic" in Kalamazoo, it is likely there is a success bias in my sample composition.[12] If this is true, the Kalamazoo data would underestimate the impact of measured background characteristics, and would also underestimate biases in the effects of ability and schooling that are due to measured background. They might correspondingly exaggerate the relative importance of unmeasured background characteristics. (Unless, of course, the sibling correlations in the Kalamazoo data are lower than those that would be found in national samples. There is little evidence that the sibling correlations in the Kalamazoo data are atypically low.)

Table 3 presents the correlations between brothers' characteristics for the Kalamazoo sample. Like its predecessor, the 1962 OCG I survey, the 1973 OCG II survey asked respondents to report on a brother's educational attainment. Correlations between a respondent's characteristics and his brother's education in the Kalamazoo sample are quite similar to analogous

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[11] Intergenerational correlations are lower in the 1966 Detroit Area Survey than in the 1962 OCG I survey. See Duncan, Featherman, and Duncan (1972, p. 46).

[12] There is a disproportionate number of managers, administrators, and proprietors in the sample compared to the number in the total 1970 Kalamazoo male workforce aged 16 and over, and compared to the number in the 1970 Lansing, Michigan male workforce aged 35 to 54, See Olneck, "The Determinants of Educational Attainment."

Table 3

Correlations Between Brothers Characteristics (N=346 weighted pairs)

	AGE'	IQ'	ED'	FIRSTOC'	OC'	EARN'	LNEARN'
AGE	.587						
IQ	-.158	.469					
ED	-.157	.400	.549				
FIRSTOC	-.142	.326	.427	.394			
OC	-.120	.300	.378	.321	.309		
EARN	-.032	.178	.285	.231	.225	.237	
LNEARN	-.050	.169	.269	.211	.218	.219	.220

NOTES:

AGE = Age
IQ = Test score
ED = Education
FIRSTOC = Initial occupation
OC = Current occupation
EARN = Earnings
LNEARN = Natural logarithm of earnings

a. Primes denote the second member of a given pair. Correlations were computed from a tape on which every pair appears twice, with order reversed. This makes the product moment correlations equal to intraclass correlations.

correlations in a subsample of OCG II respondents aged 35 to 59 who reported their brothers' educations.[13] Sibling correlations on cognitive ability vary depending on the nature, reliability, and timing of the test. My correlations involving brother's test score include no aberrant values.[14] Those involving brother's initial occupation tend to be somewhat higher than analogous correlations reported by Behrman, Taubman, and Wales [1976] for fraternal twins, but the differences are not generally large, and in the case of the initial occupation-ln earnings cross-sib correlation there is virtually no difference. My correlations involving brother's occupation are similar to those reported elsewhere, with the exception of Behrman, Taubman, and Wales [1976], whose value for the correlation between the Duncan scores of DZ twins in the NAS-NCR sample is unusually low.[15] My correlations involving brother's earnings are difficult to assess. There are few other studies that have data on brothers' earnings. My correlations tend to lie in the middle of values reported elsewhere. Because of small sample sizes, age restrictions, and unusual

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[13] In a check in the Kalamazoo data, I found that respondents' reports of their brothers' educations had almost the same correlations with respondents' characteristics as did brothers' own reports of education. The degree of similarity between correlations involving brother's education in the Kalamazoo and OCG II samples would probably not be changed if OCG II had interviewed brothers.

[14] See Gertrude H. Hildreth, The Resemblance of Siblings in Intelligence and Achievement (New York: Teachers College, 1925), and Mary Corcoran, Christopher Jencks, and Michael Olneck, "The Effects of Family Background on Earnings," American Economic Review 66, May, 1976, 430-435.

[15] See Christopher Jencks, et al., Inequality: A Reassessment of the Effect of Family and Schooling in America (New York: Basic Books, 1972); Albert Hermalin, "The Homogeneity of Siblings on Education and Occupation," doctoral dissertation, Princeton University, 1969; David Eaglesfield, "The Effects of Family Background," in Who Gets Ahead? ed., Christopher Jencks, draft, Chapter 9 (New York: Basic Books, forthcoming).

sample definitions, these other studies are suspect as regards their generalizability. But that is true also of the Kalamazoo data.[16] This means that my results with respect to the importance of family background on earnings should be viewed with even more caution than my other results.

Section 3. The Impact of Family Background

This section considers the overall impact of family background on sons' characteristics, and the directions through which the influences of family background are passed. It does not consider the absolute effects of any given measured background characteristic.[17]

Sibling Resemblance

If family background were adequately measured by socioeconomic variables, if, on the average, background characteristics affected each brother in a family to the same degree, and if the individual characteristics of one brother did not directly affect the characteristics of another brother, the correlation between brothers on any outcome could be correctly predicted from a path model relating the outcome to background measures. Figure 1 presents such a model, based on the regression of test score on father's education's, father's occupation, and siblings for the 692 individuals

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[16] See Behrman, Taubman, and Wales, "Controlling Effects of Genetics and Family Environment," and Corcoran, Jencks, and Olneck, "The Effects of Family Background on Earnings." Restricting the Kalamazoo sample to pairs of brothers who differ in age by three or less years exaggerates rather than narrows discrepancies between correlations in the DZ portion of the NAS-NCR twin sample and the Kalamazoo brothers sample. Except for correlations involving ln earnings, the NAS-NCR DZ twin correlations tend to be appreciably lower than analogous correlations in the Kalamazoo sample.

[17] For regressions of sons' outcomes on background measures see Olneck, "The Effects of Education on Occupational Status and Earnings."

comprising my sample.[18] The diagram simply applies the results of the regression to the test scores of two brothers rather than to the score of only one individual.

The fundamental path theorem expresses the correlation between two endogenous variables, $r_{ij} = \Sigma_{p_{ik}r_{jk}}$, where r_{ij} is the correlation being analyzed, p_{ik} is a path (standardized regression coefficient) from variable K to the second of the two variables (i), and r_{kj} is the correlation between the first of the variables (j), and variable k [Duncan, 1965]. Applying the path theorem to Figure 1, we can predict the correlation between brothers' test scores from equation (1):

$$r^*_{IQ', IQ} = p_{IQ',eIQ'}r_{eIQ',IQ} + p_{IQ',IQ}r_{IQ,IQ} + p_{IQ',POPED}r_{POPED,IQ} \quad (1)$$

$$+ p_{IQ',POPOC}r_{POPOC,IQ} + p_{IQ',SIBS}r_{SIBS,IQ}.$$

Since $r_{eIQ'IQ}$ and $p_{IQ',IQ}$ are both assumed to equal 0, rewriting equation (1) with appropriate values gives equation (2):

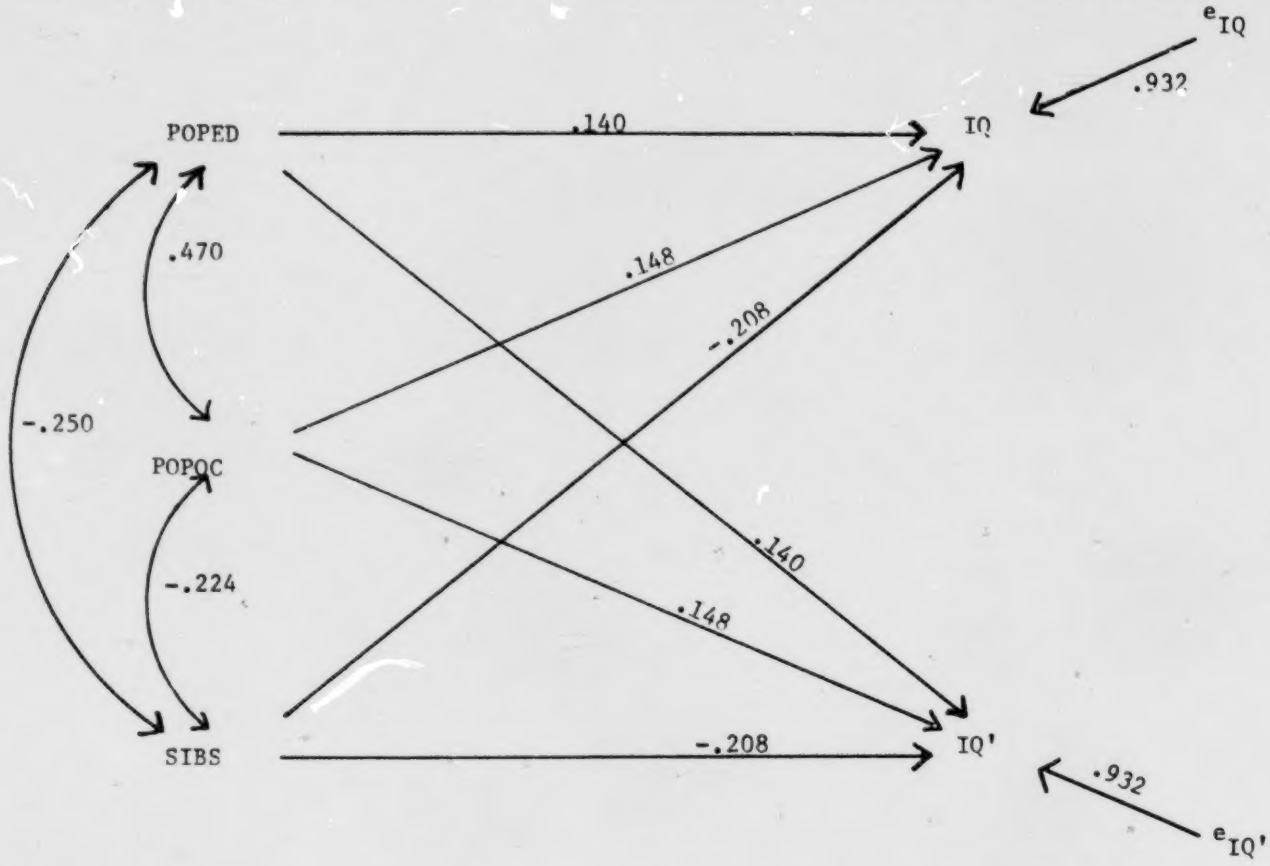
$$r^*_{IQ',IQ} = .140(.261) + .148(.260) + (-.208)(-.276) = .132. \quad (2)$$

If the correlation between brothers' test scores arises only because of the effects of father's occupation, father's education, and siblings, we would expect the sibling correlation on test scores to be 0.132. This is exactly the proportion of variance in individual scores explained by the regression of test score on the three background measures. This can

[18] Adding measures of maternal education, family composition, paternal nativity, father white-collar, and significant nonlinear and interaction terms raises the proportion of variance explained by measured background slightly, but never by more than 0.037 for any outcome. Consequently, I have used only three basic background variables in the present analyses.

Figure 1

Path Model Relating the Test Scores of Two Brothers to Measures of Socioeconomic Background



be seen by comparing the equation predicting the sibling correlation to the equation for R^2 for a dependent variable, controlling one or more independent variables.

The equation for R^2 is $R^2_{i.kj} = \sum_{k}^{j} p_{ij} r_{ij}$, where $R^2_{i.kj}$ is the proportion of variance in (i) explained by the regression of (i) on variable (k) and (j); p_{ik} is the path from (k) to (i); and r_{ik} is the correlation between (i) and (k). Since the correlation between measured background variables and individual outcomes is assumed to be the same for all brothers (e.g., $r_{IQ',POPED} = r_{IQ,POPED}$), equation 2 is nothing more than the equation for R^2 in a regression of test score on father's education, father's occupation, and siblings.

Column 1 of Table 4 gives the predicted sibling correlations for test scores, educational attainment, initial occupation, current occupation, earnings, and ln earnings. Column 2 gives the observed correlations. The results in Table 4 show that analyses which equate family background with measured socioeconomic variables will fall far short of accounting for resemblance among brothers on test scores, education, and economic attainment. Moreover, even if the actual value for the sibling correlation on test scores is assumed prior to predicting other sibling correlations, and test scores are incorporated into models predicting subsequent outcomes, the predictions will fall short. There are substantial advantages and disadvantages associated with family to family variations within equal

Table 4

Comparison of Sibling Resemblance Predicted by the Effects of Socioeconomic Background to Observed Sibling Resemblance (N=346 weighted pairs)

Variable	Predicted Sibling Correlation[a]	Observed Sibling Correlation	Residual Standard Deviation Controlling Socioeconomic Background[b]	Residual Standard Deviation Controlling Brothers Shared Background[c]
1. Test Score	.132	.469	14.27	11.16
2. Education	.253	.549	2.36	1.83
3. Initial Occupation	.209	.394	21.17	18.53
4. Current Occupation	.088	.309	22.13	19.26
5. Earnings	.061	.237	7397.29	6668.10
6. Ln Earnings	.055	.220	0.44	0.40

NOTES:

a. R^2 from regressions in which father's education, father's occupation, and siblings are the independent variables.

b. Father's education, father's occupation, siblings.

c. Calculated as $[1-r_{sib}]^{1/2}$ S, where r_{sib} is the sibling correlation and S is the standard deviation variable reported in Table 1. This is <u>not</u> the observed within-pair standard deviation $[(1-r_{sib})/2]^{1/2}$. The observed within-pair standard deviation is less than the total standard deviation even when the sibling correlation is zero.

levels of measured socioeconomic background that are not mediated by tested ability.[19]

Unless the brothers in the Kalamazoo sample are unusually similar, it is unlikely that I have substantially overestimated the relative importance of unmeasured aspects of family background for any outcome with the exception of current occupational status. Except for current occupation, R^2 from analogous regressions for the OCG II sample aged 35 to 59 are quite similar to those for my sample.[20] For current occupation, R^2 is appreciably higher in the OCG II data than in the Kalamazoo data. This suggests that unmeasured background factors may not be as important for that outcome as my data suggest, unless, of course, the sibling correlation on occupation in the nation as a whole is much larger than it is in my data.

Nor is it likely that I have overestimated the importance of unmeasured background factors relative to measured factors because of measurement error. When I attempt to correct my correlations for measurement error, $R^{2'}$ rise, but so do sibling correlations. Predicted sibling correlations based on corrected data underestimate the corrected sibling correlations by almost the same proportions as in the observed data. The

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[19] The predicted sibling correlations for education, initial occupation, current occupation, earnings, and ln earnings, taking into account sibling resemblance on test scores are 0.353, 0.264, 0.165, 0.090, and 0.082. These predictions are actually too high for all but the earnings variables, since they are based on the effects of test scores controlling only measured background. The predictions for the earnings variables are somewhat low, since the effects of test scores on earnings and ln earnings are greater controlling all background common to brothers than they are controlling only measured background variables. See below, Section 4.

[20] Adding variables measuring family composition, race, and farm background never raises R^2 by greater than 0.022 in the OCG II data I analyzed.

only outcome for which there is appreciable improvement in prediction is initial occupation.[21]

Differences Between Siblings

If the distributions of the outcome measures were normal, we could calculate the average differences between two randomly picked individuals and compare them to the average differences between two randomly chosen brothers.[22] Because the distributions of outcome variables depart to some extent from normality, we must calculate average differences between brothers directly, and, assuming similar distributions within and between pairs, infer the average differences between randomly picked individuals from the observed differences between brothers and the sibling correlations.

The average pair of brothers in the Kalamazoo sample differs by almost 12 points on test scores, 1.78 years on educational attainment, 19 points on initial occupational status, 21 points on current occupational status, 6690 dollars on earnings, and 0.406 on ln earnings. Assuming that the ratio of differences between randomly chosen individuals and pairs of brothers is $1 : [1-r_{sib}]^{1/2}$, suggests that the average difference between randomly paired individuals in my sample is 16 points on test scores, 2.66 on years of schooling, 24 points on

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[21] See Olneck, "Determinants of Educational Attainment," Chapter 4, for these comparisons, and for the derivation of my corrections for measurement error.

[22] Jencks et al., Inequality, pp. 201, 239-240 report such comparisons for occupational status and income. They erroneously refer to the formula for average sibling differences as 1.13 times the within-pair standard deviation. The formula which they actually give, i.e. $1.13\ [1-r_{sib}]^{1/2}s$, involves the within-pair standard deviation corrected for degrees of freedom. See Column 4 in Table 4.

initial occupational status, 25 points on current occupational status, 7690 dollars on earnings, and 0.460 on ln earnings.

Thus, despite the results in Table 4 showing that family background has substantially larger effects than ordinary sociological analyses might imply, the effects are nonetheless modest when viewed against the overall degree of inequality in outcomes. This is especially true of earnings. The average difference between brothers on earnings is 87 percent as large as the difference between random individuals. Eliminating earnings differences among men raised in the same home would do far more to reduce variance in income than would eliminating differences between men raised in different families. If brothers earned the same amount as one another, while family to family differences in earnings remained unaltered, the standard deviation of the resulting distribution of earnings in the Kalamazoo Brothers sample would be 3716/7634 = 48.7 percent of the present standard deviation. But if differences explained by family background were eliminated, while differences among brothers were unaltered, the resulting standard deviation of earnings would be 6668/7634 = 87.3 percent as large as the present standard deviation.[23]

A Note on Spacing

If families treat brothers who are closer in age more alike than they treat brothers who are farther apart in age, or if brothers who are closer

[23] The standard deviation of predicted family means for earnings is $7634(.237)^{1/2} = 3716$. The standard deviation of earnings eliminating the effects of family background is 6668.

For similar comparisons for ln earnings in several data sets, see Corcoran, Jencks, and Olneck, "The Effects of Family Background on Earnings."

in age encounter more common influences outside the home than do widely-spaced brothers, we would expect brothers who are farther apart in age to resemble each other less than closely-spaced brothers. On the other hand, if sibling resemblance is due to genetic influences or if the extent to which brothers have similar environments does not depend on how close in age they are, we would expect the degree of resemblance between brothers to be unaffected by age differences. My evidence is not fully consistent with either alternative, though it generally supports the second.

Absolute differences on all outcomes except current occupational status are unrelated to age differences. The correlation between absolute age difference and absolute status difference is 0.145 ($t=2.70$). Occupational differences between brothers do not systematically favor older or younger members of a pair. The effect of signed age differences on occupational differences among brothers is insignificant. Therefore, while brothers who are farther apart in age are likely to differ more from one another on occupational status than brothers who are closer in age, the direction of the difference cannot be predicted.

If the overall variances of variables were different among individuals who came from widely-spaced pairs than they are among individuals from closely-spaced pairs, sibling correlations could differ even though absolute differences did not vary by age-spacing. To investigate this possibility, I divided my sample into pairs of brothers three or less years apart in age, and pairs more than three

years apart in age. Table 5 shows the sibling correlations and the within-pair standard deviations for the two groups.

The only dramatic difference between the results for the two groups involves current occupation. The correlation between brothers' occupations is 0.469 among pairs three or less years apart in age, but only 0.181 among men more than three years apart in age. Since brothers from closely-spaced pairs are not significantly more likely to have similar educational attainments and initial occupations than brothers from widely-spaced pairs, this result is puzzling. It suggests that common family background has a direct impact on occupational status for closely-spaced brothers, but that widely-spaced brothers resemble each other on occupational status only to the extent that they have similar amounts of education and hold similar jobs when they finish school.[24] If this explanation were correct, however, I would expect a similar result with respect to earnings. No such pattern is apparent in these analyses, so in the absence of further evidence, it seems reasonable to attribute the finding concerning occupation to sampling error,[25] and to conclude that

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[24] In a model predicting occupation that takes into account the effects of education and initial occupation, the correlation between the error terms for brothers is 0.284 for pairs three or less years apart in age, but only 0.001 for pairs more than three years apart in age.

[25] It is not due to the presence of outliers. I looked at cross-tabulations of brothers' Duncan scores categorized into 5 point intervals for the two groups. The number of pairs with very large differences in Duncan scores is similar for widely-spaced and closely-spaced brothers. In general, the spread of brothers' Duncan scores tends to be greater for all levels of respondents' score for widely-spaced brothers than for closely-spaced brothers.

There is some suggestion that a similar conclusion might hold for earnings when brothers are very far apart in age. The correlation between earnings for brothers five or less years apart in age is 0.281, but it is only 0.108 for brothers more than five years apart. However, the difference between these correlations is not significant, and the correlation between absolute age difference and absolute earnings difference is only 0.054.

Table 5

Sibling Correlations and Within-pair Standard Deviations for Brothers Three or Less Years Apart in Age and for for Brothers More than Three Years Apart in Age

Variable	Sibling Correlation		Within-Pair Standard Deviation	
	3 or Less (N=155 pairs)	More than 3 (N=197 pairs)	3 or Less (N=155 pairs)	More than 3 (N=197 pairs)
Test Score	.516	.434	7.47	8.24
Education	.570	.531	1.32	1.27
Initial Occupation	.424	.379	13.06	12.97
Current Occupation	.469	.181*	12.02	14.75*
Earnings	.266	.183	5005	4542
Ln Earnings	.196	.201	.331	.261*

NOTE:

*Significantly different at the .05 level.

the extent to which brothers enjoy common background influences is similar regardless of age differences. The data cannot be used to determine whether this is because family-related environmental influences are stable, or because sibling resemblance on outcomes is due to genetic resemblance between brothers.

Models of the Effects of Family Background

In order to investigate the extent to which family background exercises direct effects on outcomes, the extent to which families that confer advantage on one outcome do so on others, and the extent to which the effects of schooling and ability transmit background rather than introduce variation in outcomes which is independent of background, I constructed two models that account for the observed individual and cross-sibling correlations among test scores, education, and earnings.[26] They are shown in Figures 2 and 3.

In Figure 2, the effects of family background are represented as derived from a set of correlated, but unmeasured variables that affect one and only one outcome. The values of the paths from these variables represent the effects of family background necessary to account for observed sibling correlations. The hypothetical variables themselves (except EF_{IQ}) may be thought of as representing the advantages or disadvantages family membership confers net of the effects of measured variables. The variable EF_{EARN}, for example, measures the tendency of two brothers to have similar deviations from the earnings expected for each of them on the basis of educational attainment and test scores. EF-IQ represents the total effects

[26] For similar models which include initial and current occupational status see Olneck, "Determinants of Educational Attainment."

Figure 2

Model of Individual Attainment Omitting Occupational Status

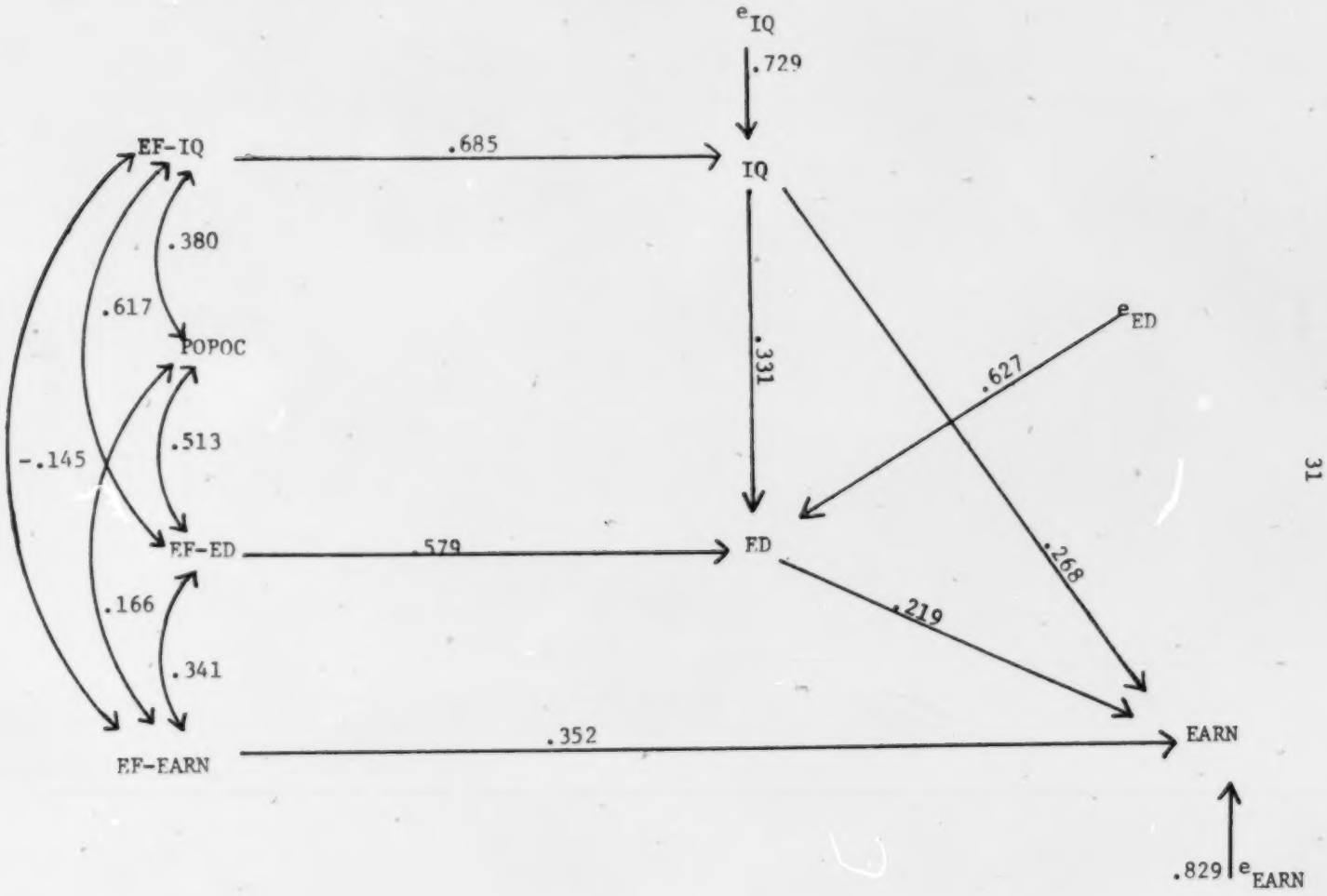
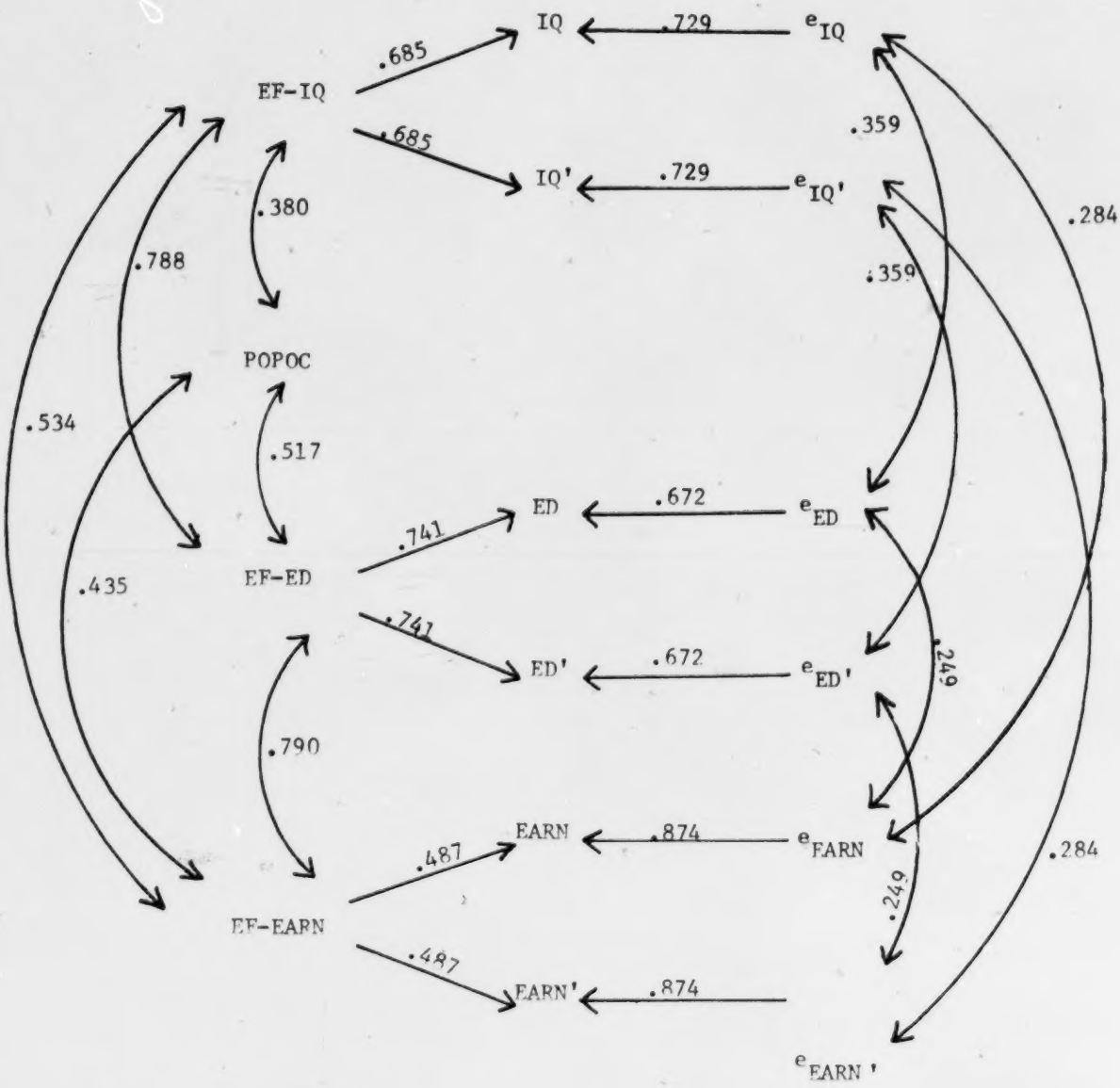


Figure 3

Model Representing the Overall Impact of Family Background on Test Scores, Education, and Earnings (Prime denotes brother.)



of shared background on brothers' test scores. The correlations among the hypothetical variables measure the extent to which families confer similar net advantages or disadvantages across outcomes. Father's occupation is included in the model, but constrained to have no effect. It is included to suggest the relationships between variables measuring the overall impact of family background and more traditional measures of socioeconomic status.[27]

Figure 2 shows that the effects of family background on years of education are not explained by sibling resemblance on tests scores (see footnote 19). Sixty-one percent of the correlation between brothers on education arises as the result of background effects that are not mediated by or shared with the effects of test scores $[(.579)^2/.549 = .611]$. Fifty-two percent of the correlation between brothers' earnings is independent of the effects of background on test scores and education $[(.352)^2/.237 = .523]$. The data do not enable us to determine what it is that brothers share that accounts for the continuing effects of background on education and earnings. Corcoran, Jencks, and Olneck [1976] suggest that the weak correlation between a hypothetical variable determining earnings, and

[27] Figure 2 is a variant of Figure B-7 in Jencks et. al., Inequality. I considered an alternative model in which orthogonal family background factors, one affecting all outcomes, one affecting all but the first outcome, one affecting all but the first two, and so one, are posited. In my data, the path to earnings from a factor common to test scores, education, and earnings is imaginary, so I abandoned the model. Nor did I estimate models in which measured background exercises direct effects, and unmeasured background factors are defined as orthogonal to measured background. I estimated the models shown below by hand calculation from observed correlations. Consequently, I cannot report standard errors for the correlations among hypothetical variables. For alternative models of family background applied to the Kalamazoo, NORC brothers, and Talent sibling data see Eaglesfield (forthcoming).

father's occupation, evident in several data sets, argues against such a variable representing economically productive skills. (Note $r_{EF\text{-}EARN, POPOC} = .166$ in Figure 2.) They suggest that it instead may proxy shared preferences for pecuniary versus nonpecuniary rewards. It is possible, however, that the variable represents a combination of personality characteristics, unmeasured skills, values, and shared information, which bear varying relationships to father's occupation. Attempts to reject or establish unitary definitions of such a variable are, therefore, potentially misleading.[28]

The correlation among the hypothetical variables indicate that families who have sons with higher test scores also tend to have sons whose educational attainments exceed the attainments expected on the basis of test scores alone, but that net earnings advantages associated with family membership are not strongly related to net educational advantages or to overall test score advantages. Indeed, families whose sons have test scores above the mean, tend, albeit weakly, to have sons whose earnings are below the earnings expected on the basis of test scores and education alone. (Note in Figure 2 that while $r_{EF\text{-}ED, EF\text{-}IQ} = 0.617$, $r_{EF\text{-}EARN, EF\text{-}ED}$ = only 0.341, and $r_{EF\text{-}EARN, EF\text{-}IQ} = 0.145$.)

Figure 3 presents a model in which the overall, rather than the net effects of family background on individual outcomes are represented. The

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[28] Olneck, "Determinants of Educational Attainment," Chapter 5 reports, however, that inclusion of high school teachers' ratings of several personality characteristics such as industriousness, dependability, and executive ability, does not improve the prediction of sibling correlations on economic outcomes.

effect of each hypothetical variable is simply the square root of the sibling correlation for the outcome associated with the variable. The correlations among the hypothetical variables are calculated by using cross-sib correlations (e.g., $r_{ED,IQ'}$), and measure the tendency of brothers who share advantages on one outcome to share advantages on others. The error terms in the model are the square root of the variance not explained by family background. The correlations between an individual's characteristics (e.g., $r_{ED,IQ}$) are accounted for by the effects of family background and a correlation between error terms. For example, the correlation between earnings and education is expressed in equations 3 and 4:

$$r_{EARN,ED} = p_{EARN,EF\text{-}EARN} r_{EF\text{-}EARN,ED} + p_{EARN,e\text{-}EARN} r_{e\text{-}EARN,ED} \quad (3)$$

$$.431 = .487(.790)(.741) + .874(.249)(.672). \quad (4)$$

The model shown in Figure 3 allows us to determine the extent to which brothers who are advantaged on one outcome tend to have similar shared advantages on other outcomes, and to determine the extent to which individual level effects are independent of family background.

The inter-correlations among the hypothetical variables in Figure 3 suggest that brothers who come from families that are unusually effective in conferring educational advantages, also tend strongly to come from families that are unusually effective in their influence on both test scores and earnings, but families that are unusually effective in their influence on test scores are not as likely to be similarly effective in their influence on earnings.

Sociologists have sometimes attempted to use the results from models like that shown in Figure 2, or models that incorporate only measured

background variables, to estimate how much of the variance in outcomes such as occupational status or earnings is due solely to the independent effects of cognitive skills or education [see especially Duncan, 1968]. These estimates are calculated by squaring standardized regression coefficients. Such attempts are potentially misleading because they may confuse different meanings of independence.

The effects of the endogenous variables in Figure 2 are independent of family background in that their values were calculated by holding background constant. They are free from the biasing effects of family background factors common to outcomes and their determinants. But the path coefficients of endogenous variables in Figure 2 are equal to the unstandardized regression coefficients of within-pair regressions multiplied by the ratios of the total standard deviations of independent and dependent variables. They, therefore, do not represent effects that produce variance in outcomes that is entirely orthogonal to family background. Effects whose magnitudes are independent of family background may nevertheless contribute to intergenerational status inheritance and sibling resemblance.[29]

I have used the results shown in Figure 3 to determine the extent to which the correlations among test scores, education, and earnings involve familial and nonfamilial components. Equations 5 and 6 represent the correlation between test scores and education as the sum of a family

[29] For a similar critique and an attempt to decompose the occupation-education relationship in Norway into familial and nonfamilial components, see Dorian Apple Sweetser, "Education and Privilege: An Analyses of Sibling Occupational Mobility," Acta Sociological 18, 1975.

related component and a component arising only from the association between scores and attainment within families.*

$$r_{ED,IQ} = p_{ED,EF-ED} r_{EF-ED,EF-IQ} p_{IQ,EF-IQ} + p_{ED,e_{ED}} r_{e_{ED} e_{IQ}} p_{IQ,e_{IQ}} \quad (5)$$

$$.576 = (.741)(.788)(.685) + (.672)(.359)(.729) \quad (6)$$

$$.576 = .400 + .176$$

The results in equation 6 show that .400/.576 = 69.4 percent of the correlation between test scores and education arises because of the association between them across families, and only .176/.576 = 30.6 percent arises because of the within-family correlation between scores and attainment. Similarly, .181/.359 = 50.4 percent of the correlation between test scores and earnings arises because of the within-family correlation between them, and only .146/.431 = 33.9 of the education-earnings correlation is due to the within-family correlation.

These results strongly suggest that relationships generally thought to represent meritocratic processes serve in larger measure to transmit family background, broadly defined, than they do to sever the ties between background and adult status. This may not be disturbing to those for whom meritocratic ideology stresses the mechanisms rather than the results of status allocation, or for those who equate background solely with socioeconomic status, but it should give pause to those for whom so-called merit (or achievement) and equal opportunity are closely

* This model, like the model represented in Figure 2, assumes that cross-sibling correlations are due solely to the effects of common background, and not at all to all to interbrother effects net of background. Thus, no cross-sib correlations between error terms are permitted. If cross-sib correlations between error terms are assumed, the model is underidentified.

linked in principle. Moreover, cognizance of the nonequalizing effects of measured cognitive skills and education should prompt reexamination of our definitions and standards of merit; those standards might survive reexamination as to their necessity and fairness. I suspect, however that their appeal lies to some extent in their presumed impact on diminishing the effects of family background, and that presumption is called into question by my results.

Section 4. Controlling Family Background

In order to determine the extent to which unmeasured background factors impart bias to estimates of the effects of cognitive skills and schooling, I ran regressions on sibling differences as well as on individual level data. Table 6 gives the results of these analyses.

Among individuals, a 10-point test score difference is associated with a 1.03 year difference in educational attainment. Controlling measured background variables reduces this effect to 0.81 years, and controlling unmeasured shared background as well reduces it further to 0.59 years. This result suggests that 1 - .59/1.02 = 43 percent of the relationship between test scores and education arises because men with higher test scores tend to come from families which somehow promote educational attainment independently of their sons' abilities. However, this result could also arise if the abilities that vary across families, and those that vary within families were different. A single ability measure is insensitive to this possibility. If abilities which vary between families strongly affect education and those which vary within families do not, reduced coefficients for a single ability measure would result when family background was controlled, even though this would

Table 6

Effects of Test Scores and Education (Standard errors of regression coefficients in parentheses; Bracketed coefficients less than 1.96 times their standard errors.)

Dependent Variable	Test Score	Education	$\bar{R}^2$[a]	Residual Standard Deviation	Other Variables Controlled
1. Education	.103 (.006)		.333	2.23	None
2. Education	.081 (.006)		.431	2.06	Socioeconomic background[d]
3. Δ[b]Education	.059 (.008)		.608	1.71[c]	Brothers' common background
4. Initial Occupation	.691 (.053)		.197	21.33	None
5. Initial Occupation	.510 (.053)		.299	19.93	Socioeconomic background
6. ΔInitial Occupation	.350 (.087)		.420	18.13[c]	Brothers' common background
7. Initial Occupation		6.242 (.232)	.512	16.63	None
8. Initial Occupation		5.170 (.264)	.525	16.40	Socioeconomic background
9. ΔInitial Occupation		5.576 (.454)	.577	15.47[c]	Brothers' common background
10. Initial Occupation	[.076] (.050)	5.997 (.283)	.513	16.61	None
11. Initial Occupation	[.062] (.050)	5.520 (.303)	.525	16.40	Socioeconomic background
12. ΔInitial Occupation	[.022] (.080)	5.526 (.488)	.576	15.49[c]	Brothers' common background
13. Occupation	.685 (.051)		.202	20.70	None
14. Occupation	.601 (.055)		.217	20.50	Socioeconomic background
15. ΔOccupation	.436 (.090)		.351	18.66[c]	Brothers' common background

Table 6 Continued (2)

Dependent Variable	Test Score	Education	$\bar{R}^2$	Residual Standard Deviation	Other Variables Controlled
16. Occupation		5.016 (.261)	.349	18.70	None
17. Occupation		5.031 (.302)	.347	18.72	Socioeconomic background
18. ΔOccupation		4.002 (.524)	.407	17.84[c]	Brothers' common background
19. Occupation	.255 (.056)	4.192 (.314)	.367	18.44	None
20. Occupation	.254 (.057)	4.280 (.342)	.362	18.50	Socioeconomic background
21. ΔOccupation	.229 (.092)	3.499 (.557)	.416	17.70[c]	Brothers' common background
14. ΔOccupation	.224 (.090)	2.150 (.639)	.441	17.32[c]	Brothers' common background, ΔInitial occupation
15. Earnings	179 (18)		.128	7130	None
17. Earnings	156 (19)		.141	7075	Socioeconomic background
18. ΔEarnings	170 (31)		.296	6404[c]	Brothers' common background
19. Earnings		1205 (96)	.185	6893	None
20. Earnings		1157 (111)	.184	6895	Socioeconomic background
21. ΔEarnings		906 (190)	.282	6469[c]	Brothers' common background
22. Earnings	83 (21)	938 (116)	.202	6820	None
23. Earnings	82 (21)	914 (126)	.202	6820	Socioeconomic background

Table 6 Continued (3)

Dependent Variable	Test Score	Education	$\bar{R}^2$	Residual Standard Deviation	Other Variables Controlled
24. ΔEarnings	133 (33)	612 (199)	.313	6327[c]	Brothers' common background
25. ΔEarnings	111 (32)	[276] (203)	.361	6102[c]	Brothers' common background, ΔOccupation
26. Ln Earnings	.0106 (.0010)		.129	.420	None
27. Ln Earnings	.0094 (.0011)		.137	.418	Socioeconomic background
28. ΔLn Earnings	.0105 (.0018)		.294	.378[c]	Brothers' common background
29. Ln Earnings		.0671 (.0057)	.166	.411	None
30. Ln Earnings		.0642 (.0066)	.166	.411	Socioeconomic background
31. ΔLn Earnings		.0499 (.0113)	.268	.385[c]	Brothers' common background
32. Ln Earnings	.0055 (.0012)	.0492 (.0069)	.186	.406	None
33. Ln Earnings	.0055 (.0012)	.0480 (.0075)	.186	.406	Socioeconomic background
34. ΔLn Earnings	.0086 (.0019)	.0310 (.0118)	.306	.375[c]	Brothers' common background
35. ΔLn Earnings	.0072 (.0019)	[.0094] (.0119)	.364	.359[c]	Brothers' common background, ΔOccupation

NOTES:

a. Calculated as 1 - (Error Variance/Total Variance) for individuals.

b. Δ indicated variables defined as sibling differences.

c. Within pair standard deviation corrected for degrees of freedom. Calculated as .5(1.4144) = .707 times the observed standard deviation of residuals for regressions of sibling differences.

d. Father's education, father's occupation, siblings.

not mean that background rather than ability causes higher educational attainment. It would only mean that the effects of the two could not be distinguished without direct measure of multiple abilities.

The results in equations 4 thru 9 indicate that estimates of the effects of cognitive skills on initial occupational status are quite sensitive to controls for family background, but that the effects of educational attainment are robust. Moreover, controlling test score differences among brothers barely reduces the schooling coefficient below the coefficient controlling only brothers' common background. These results suggest that when employers favor better-schooled young men they are either seeking characteristics that are relatively unrelated to cognitive ability and family background, or that they are poor judges of ability and background, and rely on educational credentials as an imperfect guide.[30]

Equations 13 thru 18 suggest that controlling measured socioeconomic background is inadequate to eliminate biases in estimates of the effects of test scores and schooling on current occupational status. The coefficient for test scores controlling only measured background is .601/.685 = 87.7 percent as large as the uncontrolled coefficient, while the within-pair coefficient is only .436/.685 = 63.6 percent as large as the uncontrolled coefficient. Similarly, controlling measured background does not reduce

[30] This conclusion should be generalized cautiously. It is not so strongly supported by Behrman, Taubman, and Wales, "Controlling Effects of Genetics and Family Environment." Moreover, the effects of elementary and secondary education on initial occupation in the Michigan Panel Study of Income Dynamics, and in my data are smaller and less robust than the effects of higher education. This is also true in the 1973 OCG II sample I analyzed. See Olneck, "Effects of Education on Occupational Status and Earnings."

the coefficient of education at all, but the within-pair education coefficient is reduced by 1 - (4.002/5.016) = 20.2 percent.[31]

Equation 21 indicates that controlling brother's test score differences reduces the within-pair coefficient of education. The combined ability-family background bias in the occupation-education relationship is 1 - (3.499/5.016) = 30.2 percent. This is larger than the proportionate bias suggested by other data sets that include ability measures.[32]

Equation 26 indicates that a 10-point difference in test scores is associated with an 11.2 percent difference in earnings among

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[31] In Behrman, Taubman and Wales, "Controlling Effects of Genetics and Family Environment," the within-pair education coefficient for DZ twins in the NAS-NCR sample is 92 percent as large as the uncontrolled coefficient. The cross-sibling correlation for education and occupation in that data is anomolously low compared to the analagous correlation in the Kalamazoo and OCG II data, so I tend to favor the Kalamazoo results. In the OCG II data, for 6865 respondents, 35 to 59, who reported their brother's education, controlling father's education, father's occupation, number of siblings, family composition, race, and farm background reduces the occupation-education coefficient by 15.0 percent. Using reports of brothers' education to calculate a within-pair occupation-education coefficient reduces the uncontrolled relationships by 23.2 percent. The importance of unmeasured compared to measured background factors for bias in the occupation-education relationship is less in the 1962 OCG I data than it is in the OCG II. See Olneck (1976b).

[32] See Larry J. Griffin, "Specification Biases in Estimates of Socioeconomic Returns to Schooling," Sociology of Education 49, 1976, and Olneck, "Effects of Education on Occupational Status and Earnings." Olneck assesses differential bias by level of schooling, and finds that the occupational effects of completing college are larger and more robust than the effects of completing high school.

individuals.[33] Controlling measured socioeconomic background reduces the effect slightly but among brothers the effect is virtually the same as it is without family background controlled. Moreover, among brothers, the regression coefficient for test score differences controlling schooling and occupation differences is 0.0072. The analogous coefficient for individuals, controlling socioeconomic background, schooling, and occupation differences is only 0.0037 [Olneck, 1976a].

There are three possible explanations for this result. One is sampling error. Crouse [forthcoming] reports that for the Project Talent sibling subsample, the within-pair test score coefficient for ln earnings is lower than the uncontrolled coefficient. Another is that the unmeasured aspects of family background which affect earnings, net of the effects of cognitive skills, are negatively correlated with the unmeasured aspect of background that affect test scores. Family background is consequently a suppressor variable. Figure 2 embodies this interpretation. Finally, standardized tests may measure multiple abilities, some of which exercise large direct effects on earnings and others which

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[33] Antilog 0.1060 = 1.1118. A one standard deviation difference in test scores in the Kalamazoo data is associated with a 17.6 percent difference in earnings. A one standard deviation difference in test scores is associated with a 10 percent difference in 1971 earnings and a 5.7 percent difference in 1968 earnings among 1957 Wisconsin high school graduates (Hauser and Daymont, 1976), a 9.6 percent of difference in expected 1964 earnings among NORC Veterans respondents aged 25 to 34, and 17.5 percent among Veterans 30 to 34 (Jencks, forthcoming), and a 9.2 percent difference in 1972 earnings of Project Talent 11 year follow-up respondents (Crouse, forthcoming). These comparisons indicate that estimates of the effects of tested ability vary by both age of respondents and tests. This accounts, in part, for differences among researchers in estimates of the proportionate and absolute "ability" biases in the effects of education.

may not. Brothers may resemble each other strongly on the abilities related to test scores which have weak direct effects on earnings, but may vary among themselves on the abilities related to test scores which have strong direct effects. This last possibility cannot be tested without direct measures of different abilities or skills.[34]

In the Kalamazoo data, measured socioeconomic background does not bias estimates of the effects of education on ln earnings, but unmeasured aspects of family background do. While the coefficient of education controlling father's education, father's occupation, and siblings is virtually identical to the uncontrolled coefficient, the effect of a one-year difference in education among brothers is only .0499/.0671 = 74.4 percent as large as the uncontrolled effect.[35]

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[34] James Crouse, "The Effects of Academic Ability," in Who Gets Ahead? ed. Christopher Jencks, draft Chapter 10 (New York: Basic Books, forthcoming), offers little support for this interpretation, however. The correlations between the separate components of the Project Talent Academic Composite and ln earnings do not differ significantly in the Talent 11 year follow-up.

[35] In Behrman, Taubman, and Wales' NAS-NRC twin sample, the within-DZ pair coefficient of education is .059/.080 = 73.8 percent of the uncontrolled coefficient, while the within-MZ pair coefficients are only .027/.080 = 33.8 percent as large as the uncontrolled coefficient. The difference between MZ and DZ results suggests that either controlling genes is important, or that MZ twins share more common environments than do DZ twins. See Behrman, Taubman, and Wales, "Controlling Effects of Genetics and Family Environment."

The 1973 OCG II data also suggest the importance of controlling unmeasured as well as measured background. Controlling measured socioeconomic background among 6855 respondents, aged 35 to 59, who reported their brother's education, reduces the relationship between education and ln earnings by 19.7 percent. But using the correlations among respondent's education, respondents' ln earnings, and brother's education to calculate a within-pair coefficient reduces the relationship by 36.4 percent. The 1962 OCG I data do not however, suggest dramatic differences between the education coefficients controlling measured background and unmeasured background. I have not yet investigated the possible sources of the discrepancy between the OCG I and OCG II results. See Olneck, "Effects of Education on Occupational Status and Earnings."

Equation 34 indicates that the combined ability-background bias in the education-ln earnings relationship is quite large. The within-pair coefficient of education, controlling brothers' test score differences is 0.0310. This is only .0310/.0671 = 46.2 percent as large as the uncontrolled coefficient. My results, along with those of Behrman, Taubman, and Wales [1976], suggest that when researchers work with young samples in which ability differences have small effects, or with samples that control only measured background, they will erroneously conclude that the bias in the education-income relationship is small.[36]

Note on Measurement Error

In this paper I have emphasized family background and tested ability as a source of upward biases in the observed effects of schooling. I ignored the likelihood that the effects of schooling are biased downward to some extent because of measurement error. Bishop [1976] has noted that the use of sibling data can exacerbate the problem of measurement error, and has argued that the within-DZ twin pair unstandardized coefficient

[36] The question may be raised as to whether it is more appropriate to estimate and compare proportionate or absolute biases across samples or within populations sampled longitudinally. If the uncontrolled effects of education differ between samples, the proportionate biases will differ even when absolute biases are the same. In longitudinal studies, if the effects of education rise faster then the effects of test scores or background, the proportionate bias will fall even though the absolute bias increases. It is probably best to report both absolute and proportionate biases. See Robert M. Hauser and Thomas N. Daymont, "Schooling, Ability and Earnings: Cross-Sectional Findings 8 to 14 Years After High School Graduation," Center for Demography and Ecology Working Paper no. 76-19, Madison: University of Wisconsin, July 1976); Griffin, "Specification Biases;" and Olneck, "Effects of Education on Occupational Status and Earnings."

Olneck, "Effects of Education on Occupational Status and Earnings," indicates that the observed effects of elementary and secondary schooling are more biased than the effects of higher education.

of schooling in an earnings equation is at a maximum only 83 percent of the true effect. However, the accuracy of educational reports in the Kalamazoo data appears to be slightly higher than in the CPS data Bishop analyzed. My results would indicate that if there were no other omitted variables, the observed within-pair coefficient of education could be 89 percent of the true coefficient.[37]

However, the Kalamazoo data also include an ability measure. The remaining bias in the within-pair education coefficient due to measurement error depends on the relative extent of error in the sibling differences of schooling and test scores. Since the ratio of error variance to the variance of sibling differences in education appears to be smaller than the analogous ratio for test scores, adding test score differences reduces the remaining downward bias in the within-pair education

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[37] Bishop estimated the correlation between reported and true values as 0.90, assuming that errors in separate reports of education are correlated 0.40 (Bishop, "Reporting Errors," p. 5). I estimated the correlation between true and reported values of education in the Kalamazoo data as 0.964 (Olneck, "Determinants of Educational Attainment," pp. 172-178).

I calculated the error variance of schooling as $(2.73)^2 (1 - 0.964^2) = 0.5292$. Bishop gives the ratio of the observed to the true coefficient as $b_t/\beta = 1/\alpha \left[1 - \frac{2V(ui)}{V(\Delta P)}\right]$ where

β = true coefficient
b_t = observed coefficient
α = correction for floor and ceiling effects producing a correlation between the errors in measurement and true values.
$V(u_i)$ = error variance in education
$V(\Delta P)$ = variance of sibling differences in education.
Adopting Bishop's values of $\alpha = 0.95$, I have $bt/\beta = [1 - 2 (.5292)/6.720] : .95 = .887$.

coefficient.[38] Therefore, unless there are important remaining omitted variables the observed within-pair education coefficient, controlling test score differences, could well be close to 90 percent of the true coefficient. If this were true, the bias in the observed coefficient would still be 1 - (1.11)(.0310)/.0671 = 48.7 percent.

[38] Assuming random errors and a reliability of 0.929, the error variance in schooling is $(2.73)^2(1-0.929) = 0.5292$. The ratio of error variance to the variance of sibling differences is 0.5292/6.7288 = .07865. If errors in test scores are random, assuming a reliability of 0.900 yields an error variance of $(15.32)^2(1-0.900) = 23.3292$. The ratio of error variance in test scores to the variance of sibling differences is 23.3292/249.5294 = 0.0935 See Bishop, "Reporting Errors."

Section 5. Summary and Discussion

Standard sociological variables do not adequately measure family background. We would reach this conclusion even if we included measures of parental income, and if we measured background variables more accurately. Family background exercises continuing effects on adult earnings and occupational status that are not mediated by measured ability or educational attainment. Nevertheless, the differences between brothers on measures of economic success are quite large relative to differences in the general population.

Measured ability and education, which are often thought to represent "meritocratic" characteristics, in part because they are presumed to significantly diminish the ties between background and attainment, transmit background more than they reduce its effects. If the correlations between test scores and education, and education and ln earnings arose solely from effects that were orthogonal to background they would be only one-third of their present magnitudes.

Controlling measured socioeconomic variables does not fully eliminate biases due to background in the effects of test scores on educational attainment, and in the effects of education on current occupational status and earnings. The effect of measured ability on earnings among brothers is, however, the same as it is among unrelated individuals. This result is anamolous, and may well be due to sampling error.

My results should encourage sociologists to investigate in more detail the processes by which families influence the destinies of their children. Unitary conceptions of family background do not account for

the continuing effects of background on various outcomes. The sources of the net effects of background on one outcome are weakly related to the sources of the net effects of background on other outcomes. (See Figure 2.)

They should also encourage econometricians analysing bias in the income-schooling relationship to posit multiple omitted variables. Family background and test scores both impart bias to the schooling coefficient. While background and test scores might be imperfect measures of a single ability, it is likely that persistence in school and higher earnings are related to more than one common factor.

I would hope, however, that the principal impact of my results would be to encourage others to reconsider the theoretical and ideological underpinnings of similar research. Researchers investigating the relationships among family background, test scores, education, and economic success are implicitly engaged in normative discourse even if they only report technical analyses. Their work is part of an ongoing discussion of equal opportunity, and embodies societal commitments to shared conceptions of merit and entitlement.[39] It also embodies assumptions concerning the importance of individual characteristics for explaining individual attainments.

The choice of test scores and education as explanatory variables is intimately tied to our view that "ability" and "effort" rather than inherited advantage should predominate in the process of economic attainment.

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[39] For explicit reference to the connection between status attainment research and American values see Blau and Duncan, American Occupational Structure, pp. 432-441 and Jencks et al., Inequality, Chapter 1.

Despite the fact that our research only measures the extent to which test scores and education are related to economic outcomes, and does not directly examine the processes by which those relationships arise, we rarely question the identification of IQ and schooling with merit. Until we know more about why better-schooled and higher-scoring individuals are economically favored, we cannot know whose needs and interests are served by the use of so-called meritocratic criteria.

Models of individual attainment embody the assumption that differences in adult success can be explained by differences in individual characteristics. Inquiry centers on whether the important characteristics are those which are "fair" (e.g., schooling), "unfair" (e.g., background), or unmeasured (i.e. error terms). Two prior assumptions are implicit in the assumption that individual attainments can be explained. One is that distribution of attainments or rewards is causally produced by the characteristics of individuals. Economists assert this assumption by calling their models "structural equations." The other, which is a corollary of the first, is that the distribution of rewards is not fixed, but will respond to changes in the distribution of individual characteristics.

These assumptions, while normatively appealing because of their affinity with traditional American values of hard work and individual effort, obscure the capriciousness and randomness that my results and those of others suggest characterize the economic game. My results suggest that differences in family background, measured cognitive ability, and schooling are not primary sources of economic inequality among adults. Seventy percent of the variance in earnings in my sample remains

unexplained after the effects of background, test scores, and schooling are taken into account.[40] This suggests that research paradigms that inherently reinforce the view that our own economic fates and the overall distribution of economic rewards are generated by personal characteristics should be seriously questioned, and emphasis in economic research should be concentrated on the systemic factors determining inequalities in economic rewards. In sociology, a more fruitful pursuit than the further refinement of path models would be an assessment of the ideological antecedents and impact of the dominance of the status attainment school.

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[40] For an argument that genetic endowments explain substantial amounts of variance in earnings see Behrman, Taubman, and Wales, "Controlling Effects of Genetics and Family Environment." For a critique of Behrman, Taubman, and Wales see Arthur Goldberger, "Twin Methods: A Skeptical View," Paper prepared for presentation at the Mathematical Social Sciences Board Conference on Kinometrics, Williamstown, Massachusetts, May 1976.

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